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## (54) Method of and arrangement for motion detection in an interlaced television picture obtained after film-to-television conversion.

(57) The motion detection is based on picture signal value comparisons between picture elements (P) in consecutive, interlaced television pictures (n-2, n-1), (n, n+1), (n+2, n+3), motion or no motion, respectively being determined in dependence on the fact whether comparison results exceed or do not exceed a threshold value. Changes in picture information between movie pictures (MP1, MP2, MP3) can negatively influence the telecine television motion detection if they make use of a preceding and a subsequent television picture. To prevent this, an instantaneous picture element (P1) in a first field (n) of a television picture (n, n+1) is compared with a number (P4, P5, P6, P7) of surrounding picture elements in a second field (n+1) and an instantaneous picture element (P11) in the second field (n+1) is compared with a number (P14, P15, P16, P17) of surrounding picture elements in the first field (n).

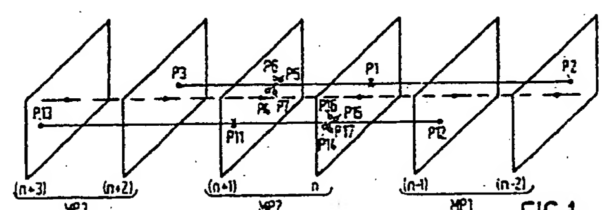


FIG.1

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## Method of and arrangement for motion detection in an interlaced television picture obtained after film-to-television conversion.

The invention relates to a method of motion detection in an interlaced television picture obtained after film-to-television conversion, the method being based on picture signal comparison between picture elements in consecutive television pictures which are assembled line and field-sequentially in frame periods consisting of two field periods, in the method, starting from a picture element in the television picture the picture signal value thereof being compared with those of a corresponding picture element in the preceding and the subsequent television picture and with those of a number of surrounding picture elements, motion or no motion, respectively, being determined in dependence on the fact whether comparison results exceed or do not exceed a threshold value.

The invention also relates to an arrangement suitable for performing such a method.

Motion detection can be utilised for various purposes. For a television transmission channel having a bandwidth which is more limited than the bandwidth of the television signal source, the motion detection can be used for a bandwidth reduction of the signal to be transmitted. During television signal conversion from one standard to an other, the motion detection can be used to provide an improved picture quality on display of the converted picture signal.

When the television signal source includes a film-to-television converter (telecine) the specific structure of the picture signal can then be used for an optimum motion detection since it is a known technique to convert 24 movie picture frames per second into 25 or 30 interlaced television pictures or frames per second, by coupling the television pictures to the film frames, so that picture information changes between consecutive film frames can only occur between predetermined television pictures. In the case of single interlace using two fields per television picture or frame the picture information components per two fields are always identical.

To provide an optimum motion detection based on picture signal value comparisons with a preceding and a subsequent television picture, a method according to the invention, is characterized, in that picture signal comparisons between an instantaneous picture element of a first or a second field, respectively, of each interlaced television picture and said number of surrounding picture elements are effected between the said instantaneous picture element and the number of picture elements present in the second or first field, respectively, of the interlaced television picture.

For a telecine television motion detection operative with a preceding and a subsequent television picture, the signal source including a film-to-television converter, this specific choice always results in an optimum detection.

An arrangement for performing the method including a memory for the respective storage and delay of the picture signal values of the picture elements of at least two television pictures and a first and a second signal comparison and threshold circuit coupled to the memory for performing the picture signal value comparisons, is characterized, in that the memory comprises at least five field memories and from its outputs supplies the picture signal values of six consecutive fields (n-2), (n-1), n, (n+1), (n+2) and (n+3) of picture elements of three television pictures, the arrangement including a first and a second change-over device via which inputs of the first and second signal comparison and threshold circuit, respectively, are coupled at the frame frequency to memory outputs for supplying the signal picture values of the picture elements of the fields (n-2), (n-1) and (n+2), (n+3), respectively, whereas further inputs of the first and second signal comparison and threshold circuit are coupled to memory outputs for supplying the picture signal values of the picture elements of the fields (n) and (n+1).

The invention will now be described in greater detail by way of example with reference to the accompanying drawing, in which

Fig. 1 shows by way of illustration of the method according to the invention six schematically drawn fields of picture elements, and

Fig. 2 is a block circuit diagram of an arrangement according to the invention.

Fig. 1 shows six television fields of sequentially occurring picture elements, denoted by (n-2), (n-1), n, (n+1), (n+2) and (n+3). Let the fields (n-2) and (n-1) belong to an interlaced television picture which corresponds to one motion picture frame MP1. The same holds for the fields n, (n+1) and (n+2), (n+3), respectively, which belong to one motion picture frame MP2 and MP3, respectively. This results in that picture information changes can only occur between television pictures (n-2, n-1), (n, n+1) and (n+2, n+3), with a first field (n-2), n and (n+2), respectively and a second field (n-1), (n+1) and (n+3). The picture information in the fields (n-2) and (n-1), n and (n+1), and (n+2) and (n+3), respectively is the same, the only difference being that as a result of the interlace the picture elements at the line and field-sequential structure

have been shifted into the field direction.

In Fig. 1 it is assumed that during the occurrence of the first field n an instantaneous picture element at which motion is to be detected, is denoted by P1 and a cross. Likewise, during the second field (n+1) there is an instantaneous picture element P11 (cross). A picture element corresponding to P1, in the preceding picture (n-2, n-1) and in the subsequent picture (n+2, n+3) is denoted by P2 and P3, respectively, and a circle. A number of picture elements P4, P5, P6 and P7 (circles), surrounding the picture element P1, in the picture (n, n+1), are denoted by (P4, P5, P6, P7). The picture elements P4 and P5 occur in the picture (n, n+1) in the line or horizontal direction, whereas the picture elements P6 and P7 are located in the field or vertical direction. In a similar manner, corresponding picture elements P12 and P13 and a plurality (P14, P15, P16, P17) of surrounding picture elements, represented by circles, are shown at the instantaneous picture element P11. In the example four surrounding picture elements are used, but larger numbers are alternatively possible.

For the motion detection, picture signal values associated with the picture elements P are compared with each other and motion or no motion, respectively, is determined when a threshold value is exceeded or not exceeded. In this situation comparison results can be combined via logic OR- and/or AND-functions to enable an optimum decision whether there is motion or no motion. Examples thereof are an element-by-element comparison (P1, P2) or (P1, P3), an element-by-element-group comparison (P1 relative to P4, P5, P6 and P7), these results thereafter being correlated with the results obtained within a block of elements each having their own comparison results. The same may hold for the elements P11 to P17, inclusive. The manner in which the comparison results are processed is not essential to the invention. A feature essential to the invention is the choice which the picture elements are compared to each other. This choice is illustrated in Fig. 1 and implies that the picture signal value comparison between the instantaneous picture element P1 and P11, respectively, of the first (n) and second (n+1) field respectively, of the interlaced television picture (n, n+1) are effected using the number of respective picture elements (P4, P5, P6, P7) and (P14, P15, P16, P17) present in the second (n+1) and first (n) field, respectively, of the interlaced television picture (n, n+1). This choice results in an optimum motion detection as picture information changes are absent between the fields n and (n+1). For the instantaneous picture element P1 only the information of the corresponding picture element P2 is derived from the preceding picture (n-2, n-1). For the instantaneous picture element P11 information of the corresponding picture element P13 is only derived from the subsequent picture (n+2, n+3). Consequently picture information changes between the motion picture frames do not affect the motion detection.

Fig. 2 is a block diagram of a construction of an arrangement according to the invention for performing the method of the invention illustrated by Fig. 1. MPC denotes a film-to-television converter or telecine apparatus, in which in outline a film reproduction and a television recording are shown. Let the converter MPC supply a picture signal PS which is, for example, digitised by 8-bits on an eight-fold output. The picture signal PS with picture signal values associated with the picture elements P of Fig. 1 is applied to a memory MEM for storing and delaying, respectively, the picture signal values. The Figure shows a construction of the memory MEM with a series arrangement of five field memories MEM1 to MEM5, inclusive, in the form of delay devices producing a time delay equal to a field period VT. The memory MEM has six (eight-fold) outputs at which the picture signal values associated with the picture elements P of six consecutive fields (n-2), (n-1), n, (n+1), (n+2) and (n+3) of three television pictures (n-1, n-1), (n, n+1), (n+2, n+3) are present. Instead of the structure shown in Fig. 2 there may a number of, for example, six field memories which are all sequentially connected to the output of the film-to-television converter MPC, five of these memories simultaneously applying the necessary information to the outputs of the memory MEM, whereas the sixth field memory stores an instantaneous picture signal PS.

Independent of the structure of the memory MEM, the memory outputs carrying the picture signal values of the picture elements P of the fields n and (n+1) are coupled to respective inputs of comparison circuits COM1 and COM2. In accordance with a feature of the invention a further input of the circuit COM1 and COM2, respectively, is coupled via respective change-over devices SW1 and SW2 to the memory outputs carrying the picture signal values of the picture elements P of the fields (n-2), (n-1) and (n+2), (n+3), respectively. For the sake of simplicity, the devices SW1 and SW2 are shown as mechanical switches having a main contact T0 and each two selector contacts T1 and T2, in actual practice the devices will be electronic devices. The change-over devices SW1 and SW2 are controlled from a switching signals generator GEN. In the block illustrating the generator GEN a square-wave switching signal is shown having a frame period FT of two field periods VT. The devices SW1 and SW2 switch at the frame frequency and the fields (n-2) and (n+2) are con-

veyed via the contacts T1 and the fields (n-1) and (n + 3) are conveyed via the contacts T2.

The picture signal value comparison circuit COM1 and COM2, respectively, are followed by a respective absolute-value circuit ABS1 and ABS2 and respective threshold circuit THR1 and THR2 subsequent thereto, the Figure showing multiple connection lines. The threshold circuit THR1 and THR2, respectively, is operative with respective threshold values th1 and th2 which can be constant or adaptive, depending on the amplitude of the picture signal value differences. Fig. 2 shows a first and second signal comparison and threshold circuit (COM1, ABS1, THR1) and (COM2, ABS2, THR2), respectively. The outputs of the signal comparison and threshold circuits (COM, ABS, THR) are coupled to inputs of an OR-gate OR. Let it be assumed that if there is motion this corresponds to a logic 1 at the outputs of the threshold circuits THR1 and THR2, so that an output MOT of the gate OR which is at the same time the output of the arrangement, carries the information indicating motion if at least one logic 1 occurs. Should the detection there is indeed motion correspond to a logic 0 originating from the circuits THR1 and THR2, the OR-gate must be replaced by a NAND-gate. Both cases require an OR-function to arrive at the conclusion that motion is indeed present.

Comparing Fig. 2 to Fig. 1 shows that during the first fields of television pictures, for example n of the picture (n, n + 1), the circuit COM1 is operative with the fields (n-2), n (with the instantaneous picture element P1) and (n + 1), and the circuit COM2 is operative with the fields (n + 2), n (with the instantaneous picture element P1) and (n + 1). During the second fields of the television pictures, for example field (n + 1) of the picture (n, n + 1), the circuit COM1 is operative with the fields (n-1), (n + 1) (with the instantaneous picture element P11) and n, and the circuit COM2 is operative with the fields (n + 3), (n + 1) (with the instantaneous picture element P11) and n.

## Claims

1. A method of motion detection in an interlaced television picture obtained after a film-to-television conversion, the method being based on picture signal comparison between picture elements in consecutive television pictures which are assembled line and field-sequentially in frame periods consisting of two field periods, in the method, starting from a picture element in the television picture, the picture signal value thereof being compared with those of a corresponding picture element in the preceding and the subsequent television picture and with those a number of surrounding picture elements, motion or no motion, respectively, being determined in dependence on the fact whether comparison results exceed or do not exceed a threshold value, characterized in that picture signal commparisons between the instantaneous picture element of a first or a second field, respectively, of each interlaced television picture and said number of surrounding picture elements are effected between the said instantaneous picture element and the number of picture elements present in the second or first field, respectively, of the interlaced television picture.

2. A method as claimed in Claim 1, characterized in that whether there is indeed motion is determined via a logic OR-function in the processing of the comparison results of the comparisons of the instantaneous picture element with the preceding and the subsequent television picture.

3. An arrangement for performing a method as claimed in any one of the preceding Claims, the arrangement including a memory for the respective storage and delay of the picture signal values of the picture elements of at least two television pictures and a first and a second signal comparison and threshold circuit coupled to the memory for performing the picture signal value comparisons, characterized in that the memory comprises at least five field memories and from its outputs supplies the picture signal values of six consecutive fields (n-2), (n-1), n, (n + 1), (n + 2) and (n + 3) of picture elements of three television pictures, the arrangement including a first and a second change-over device via which inputs of the first and second signal comparison and threshold circuit, respectively, are coupled at the frame frequency to memory outputs for supplying the picture signal values of the picture elements of the fields (n-2), (n-1) and (n + 2), (n + 3), respectively, whereas further inputs of the first and second signal comparison and threshold circuit are coupled to memory outputs for supplying the picture signal values of the picture elements of the fields (n) and (n + 1).

4. An arrangement as claimed in Claim 3, characterized in that, outputs of the first and second signal comparison and threshold circuit carrying a logic 1 or a 0, respectively, when motion is detected, are coupled to an output of the arrangement via an OR-gate or a NAND-gate, respectively.

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# EUROPEAN SEARCH REPORT

EP 89 20 1276

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.4) |
|---|---|---|---|
| Y | GB-A-2 165 417 (B.B.C.) * Page 1, lines 23-24; page 2, line 53 - page 3, line 48; claim 1; figures 5-7 * | 1,2 | H 04 N 5/14<br>G 06 F 15/70 |
| A | | 3 | |
| Y | GB-A-2 045 574 (QUANTEL LTD) * Page 1, lines 35-52; page 2, lines 54-113; figures 5,6 * | 1,2 | |
| A | | 3,4 | |
| A | EP-A-0 141 969 (SIEMENS AG) * Page 3, lines 8-11; abstract; figure 2a * | 1 | |

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H 04 N
G 06 F

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 22-08-1989 | WEBER-KLUZ F.M. |

CATEGORY OF CITED DOCUMENTS

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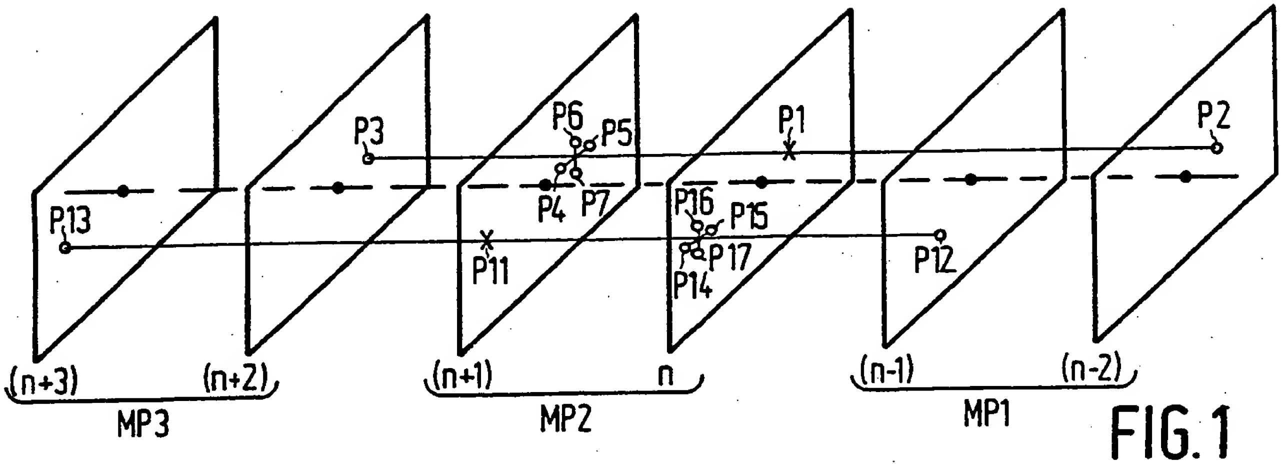
P1
P2
P3
P4
P5
P6
P7
P11
P12
P13
P14
P15
P16
P17
(n+3)
(n+2)
(n+1)
n
(n-1)
(n-2)
MP3
MP2
MP1

FIG. 1

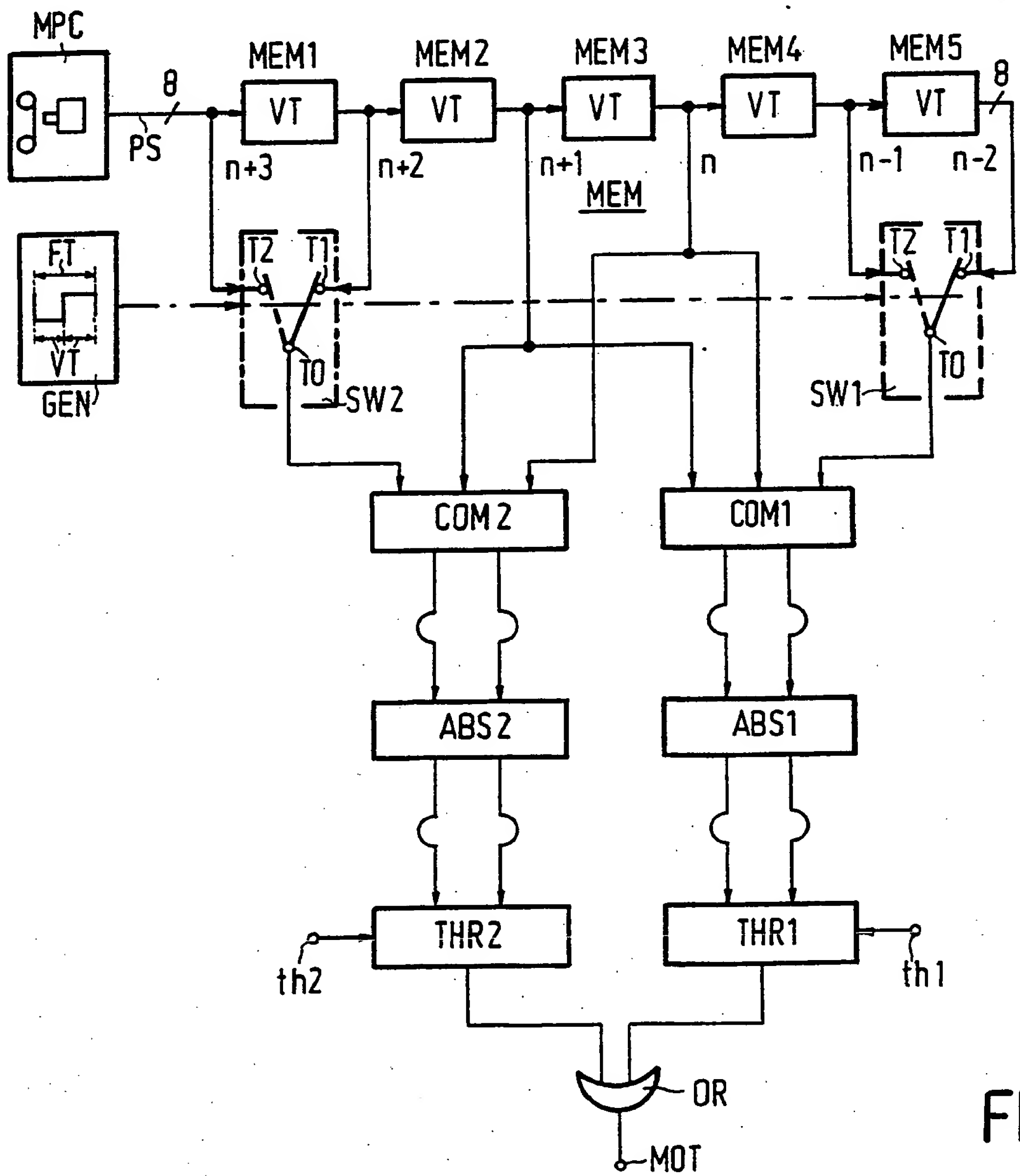
MPC
8
PS
MEM1
MEM2
MEM3
MEM4
MEM5
VT
VT
VT
VT
VT
8
n+3
n+2
n+1
n
n-1
n-2
MEM
FT
VT
GEN
T2
T1
T0
SW2
T2
T1
T0
SW1
COM 2
COM1
ABS 2
ABS1
THR2
THR1
th2
th1
OR
MOT

FIG. 2

second field buffer are coupled to the second and fourth comparators COMP2 and COMP4.

Pixel P4 (illustrated in FIG. 1) is available at the input to the first field buffer, pixel P3 is available at the input to the line buffer, pixel P2 is available at the input to the second field buffer and pixel P1 is available at the output of the second field buffer. The outputs of the comparators are applied to a counter control logic (CCL) which combine the results of the comparators and assigns a value of +1, −1 or 0, depending on the respective output values of the comparators. That is to say:

a (+1) result is assigned, if
{P1 < min(P2,P3) OR P1 > max(P2,P3)} AND
{min(P2,P3) ≦ P4 ≦ max(P2,P3)};
a (−1) result is assigned, if
{P4 < min(P2,P3) OR P4 > max(P2,P3)} AND
{min(P2,P3) ≦ P1 ≦ max(P2,P3)};

or else a (0) value is assigned if the foregoing conditions are not satisfied. These tests are effectively looking for smooth image contours between fields. Nominally successive fields provided by film mode material will exhibit smooth image contours, but video mode source material will have less smooth image contours due to the occurrence of image motion between fields.

The +1, −1 or 0 value generated by the counter control logic CCL, is forwarded to an up/down counter (UDC). That is, positive results produce an up count pulse on the up count connection U and negative results produce a down count pulse on the down count connection D and zero results produce no pulses on either connection. The UDC effectively sums the positive and negative results and forwards the data on line S to a status detector SD.

The status detector SD latches the results of the up/-down counter for respective field intervals, and assigns a positive or negative value to respective fields depending upon whether the sum over the field is positive or negative respectively. The signs of the combined data over a sequence of fields are compared to a predetermined pattern, as described above, and film-mode or video-mode is detected. The status detector can be arranged to examine sums over an entire field as illustrated in FIG. 2 or to first examine sums over field segments as indicted in FIG. 3, and combine the partial results into field results and then proceed to examine the field results. If a corresponding error occurs, the counter UDC is reset via line R.

In systems which perform interlace to non interlace scan conversion, an interpolator (INT) may be included for generating and providing interpolated video values at an output terminal EL. The interpolator has input connections to various points in the delay circuit from which to access video samples to be utilized in the interpolation process. An output from the status detector of the film/video detection circuit is coupled to an interpolator (INT) on line SW. The phase of the current field which is determined by the sign of the combined data, is also forwarded to the interpolator on line FP.

The information items on line SW and FP are advantageously used in the interpolator INT which supplies both the original as well as estimated values for one or more of the pixels P1 to P4. In the case of film mode, frames can be generated in this interpolator which consist of two fields which have been pulled together. If the film mode is not present, a double median interpolation can be advantageously carried out as is described in, for example, DE-A-4211955.

In addition, the chrominance amplitudes can also be checked in accordance with the invention and the result can be logically combined with that for the luminance.

What is claimed is:

1. A method for film-mode detection comprising:

concurrently providing pixel values from at least first and second adjacent fields of video signal;

comparing amplitude values of respective pixels from corresponding image areas of said first and second adjacent fields, and for a predetermined one of said first and second adjacent fields assigning a first value to comparison results indicating that the amplitude value of respective pixels in horizontal lines of said first adjacent field are intermediate the amplitude values of vertically aligned pixels in two horizontal lines of said second adjacent field between which said horizontal lines of said first adjacent field are disposed, and assigning a second value if the amplitude value of said respective pixels in said first adjacent field are greater than the maximum of, or lesser than the minimum of the amplitude values of said vertically aligned pixels,; and

combining the comparison results from at least a portion of respective said predetermined one of said first and second adjacent fields, to determine if values assigned said comparison results are predominantly said first or said second value, and assigning said predetermined one of said first and second adjacent fields the predominant first or second value; and

establishing film mode detection if a sequence of values assigned a predetermined number of successive said predetermined one of said first and second adjacent fields, corresponds to a predetermined pattern.

2. A method for film-mode detection comprising:

concurrently providing pixel samples from three successive fields;

comparing corresponding pixels P1 and P4 from corresponding lines of said first and third fields respectively, to vertically aligned pixel pairs, P2 and P3, from successive lines of said second field, and between which said pixels P1 and P4 are vertically disposed;

allocating a first value to the results of respective comparisons if the amplitude of pixel P1 is intermediate the amplitudes of pixels P2 and P3, and the amplitude of pixel P4 is not intermediate the amplitudes of pixels P2 and P3, and allocating a second value if the amplitude of pixel P4 is intermediate the amplitudes of pixels P2 and P3, and the amplitude of pixel P1 is not intermediate the amplitudes of pixels P2 and P3,

collating the results of comparisons over respective field intervals, and assigning said first or second values to respective fields depending upon whether comparisons for respective fields produced predominantly said first or said second value; and

comparing the sequence of first and second values assigned to successive field, for a predetermined pattern.

3. The method according to claim 2, wherein the step of collating further comprises:

collating the results of comparisons over mutually exclusive portions of respective fields;

assigning a comparison result to respective fields equal to the collated results of the respective portions if the respective portions all exhibit the same result, and assigning an error result otherwise.

4. The method according to claim 2 wherein said step of allocating includes:

assigning a (+1) as the comparing result if
$\{P1 < \min(P2,P3) \text{ OR } P1 > \max(P2,P3)\}$ AND
$\{\min(P2,P3) \leq P4 \leq \max(P2,P3)\}$;
assigning a (−1) as the comparing result if
$\{P4 < \min(P2,P3) \text{ OR } P4 > \max(P2,P3)\}$ AND
$\{\min(P2,P3) \leq P1 \leq \max(P2,P3)\}$;

assigning a (0) as the comparing result if the foregoing conditions are not satisfied.

5. The method according to claim 4, wherein the step of collating comprises:

summing the comparison results over respective second fields of video signal;

assigning a positive or negative sign to respective second fields depending upon whether the resultant sum of the comparison results over each second field is positive or negative.

6. The method according to claim 5, wherein further including:

correlating the sequence of positive and negative signs assigned to successive fields to a predetermined pattern of alternating signs; and

outputting a film-mode indication if a correlation is determined.

7. A method for film-mode detection comprising:

concurrently providing pixel samples from three successive fields, wherein first and fourth pixel samples from a first and third of said successive fields respectively, are vertically disposed between second and third pixels from a second of said three successive fields;

comparing said first and fourth pixel values with said second and third pixel values to determine whether said four pixel values represent contiguous image contours;

assigning a positive or negative value to the results of respective comparisons depending upon whether contiguous image contours are determined to occur;

summing the results of comparisons over respective field intervals, and assigning first or second values to respective fields depending upon whether the sum of results of comparisons for respective fields are positive or negative; and

comparing the sequence of first and second values assigned to successive fields, for a predetermined pattern.

8. The method set forth in claim 7 wherein said first and second values correspond to plus and minus unit values and the step of comparing the sequence of first and second values assigned to successive fields, for a predetermined pattern comprises; summing the sequence of first and second values over a predetermined number of fields and comparing the resultant sum to a predetermined value.

9. An apparatus for film-mode detection comprising:

an input terminal for applying a video signal;

delay means, coupled to said input terminal, for concurrently providing pixel values from adjacent fields of video signal;

a means, coupled to said delay means, for comparing amplitude values of respective pixels from corresponding image areas of said adjacent fields to determine whether amplitude values of respective pixels in successive adjacent fields are in a first or a second monotonically increasing or monotonically decreasing relationship; and

means, coupled to said comparing means, for determining if the comparison results over at least a portion of respective field intervals indicate that respective pixel amplitude values of said respective field intervals are predominantly in said first or second monotonically increasing or decreasing relationship, and assigning a first or second value respectively to said respective field intervals according to the predominance determined; and

means, coupled to said means for determining, for establishing film mode detection if a resulting sequence of said first and second values assigned to a predetermined number of said respective field intervals corresponds to a predetermined pattern.

10. The apparatus set forth in claim 9 wherein said delay means includes;

a cascade connection of a first field delay element, a horizontal line delay element, and a second field delay element, said first and second field delay elements each providing a signal delay of a field interval less one half horizontal line interval; and

wherein said means for comparing includes means for determining whether the pixels occurring at the input to the first field delay element have amplitudes intermediate the amplitudes of the pixels occurring at the input and output of the line delay element, and concurrently if the pixels occurring at the output of the second field delay element have amplitudes which are greater than the larger of, or lesser than the smaller of the amplitudes of the pixels occurring at the input and output of the line delay element.

11. The apparatus set forth in claim 10 wherein said means for comparing further includes:

means for determining whether the pixels occurring at the output of the second field delay element have amplitudes intermediate the amplitudes of the pixels occurring at the input and output of the line delay element, and concurrently if the pixels occurring at the input to the first field delay element have amplitudes which are greater than the larger of, or lesser than the smaller of the amplitudes of the pixels occurring at the input and output of the line delay element.

12. The apparatus set forth in claim 10 wherein pixels occurring at the input to the first delay means are designated P1, and pixels occurring at output connections of said first field delay element, said line delay element, and said second field delay element are designated P2, P3 and P4 respectively and said means for comparing includes;

means for assigning a (+1) comparison result if
$\{P1 < \min(P2,P3) \text{ OR } P1 > \max(P2,P3)\}$ AND
$\{\min(P2,P3) \leq P4 \leq \max(P2,P3)\}$;
means for assigning a (−1) comparison result if
$\{P4 < \min(P2,P3) \text{ OR } P4 > \max(P2,P3)\}$ AND
$\{\min(P2,P3) \leq P1 \leq \max(P2,P3)\}$;

means for assigning a (0) result if the foregoing conditions are not satisfied.

* * * * *